Pots were placed, mouth downwards, round the spot, and outside the hut food and domestic utensils had been thrown out.

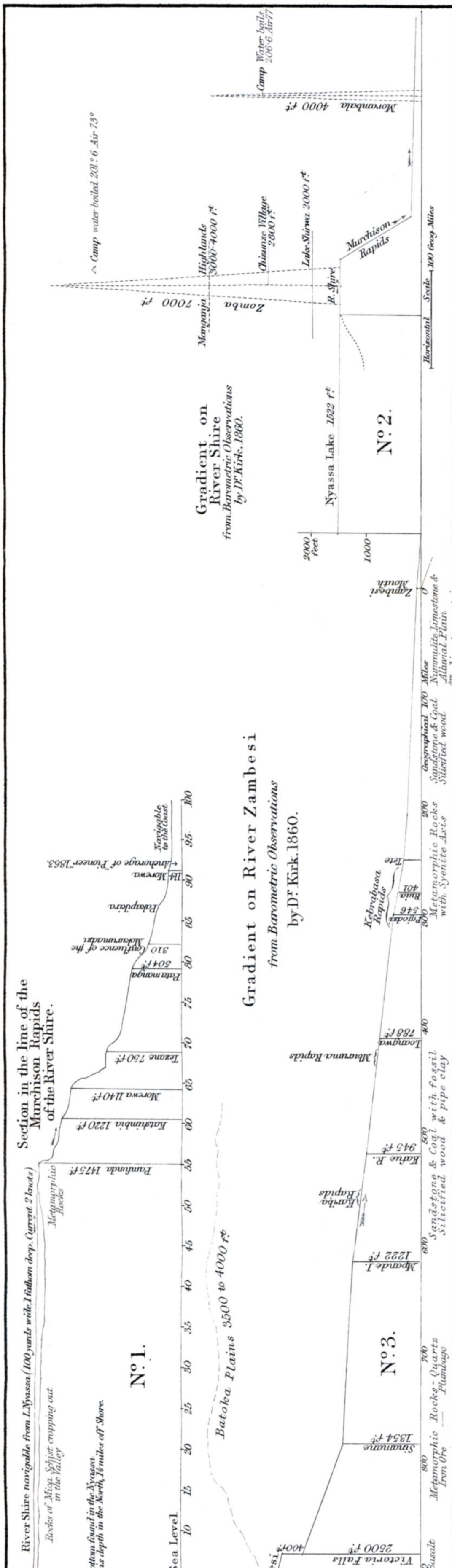
On the 9th October we reached the vessel in the bay, to find all well, having ourselves escaped with little fever, although exposed terribly to the sun.

As a path to the lake the Rovuma had certainly disappointed us. In flood, there was not water enough for our steamer; when low, our boats with difficulty had passed, and we were effectually arrested half way to the lake. If ever a local industry should spring up on its banks, the Rovuma is capable of bringing down the produce during flood, or for three months each year in boats and barges; but that day is distant. It is, however, while the Zambesi remains shut, an easy way by which to pass the hostile and extortionate coast-tribes, and so give a good start for any explorers bound to the unknown regions between the lakes of the interior, and so determine the yet vexed question of the ultimate source whence the Nilotic Lakes receive their supplies of water. Ten days from Ngomano the explorers will be at the northern end of Nyassa, or at least at the most northern point where it is known to reach.

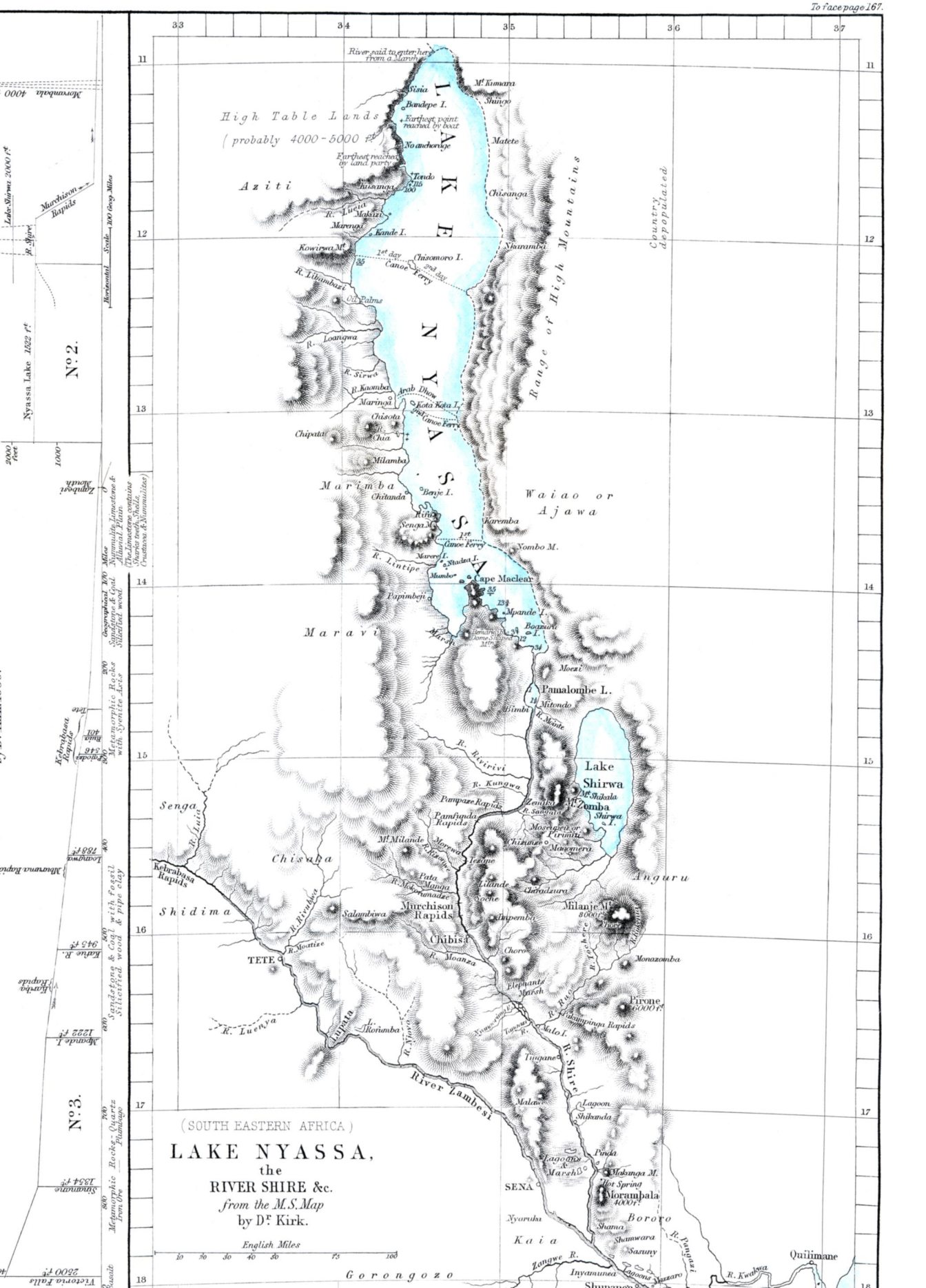
XIV.—*Notes on the Gradient of the Zambesi, on the Level of Lake Nyassa, on the Murchison Rapids, and on Lake Shirwa.* By JOHN KIRK, Esq., M.D., F.R.G.S., F.L.S. [With Diagrams.]

On the Gradient of the Zambesi.—The instruments used in determining the level of the Zambesi were the mountain barometer, aneroid barometer, and boiling-point barometer. So long as the first of these continued serviceable its indications must supersede the others. Fortunately it did not break down until we had passed 600 miles inland and a level on the Zambesi of 1222 feet. Here we left the river and ascended the Batoka hills: before doing this careful comparisons of all the instruments were made, and thus a point determined which on our return became available for checking any additional instrumental error. It was then found that the aneroid still continued adding at a steady rate to its originally *plus* error.

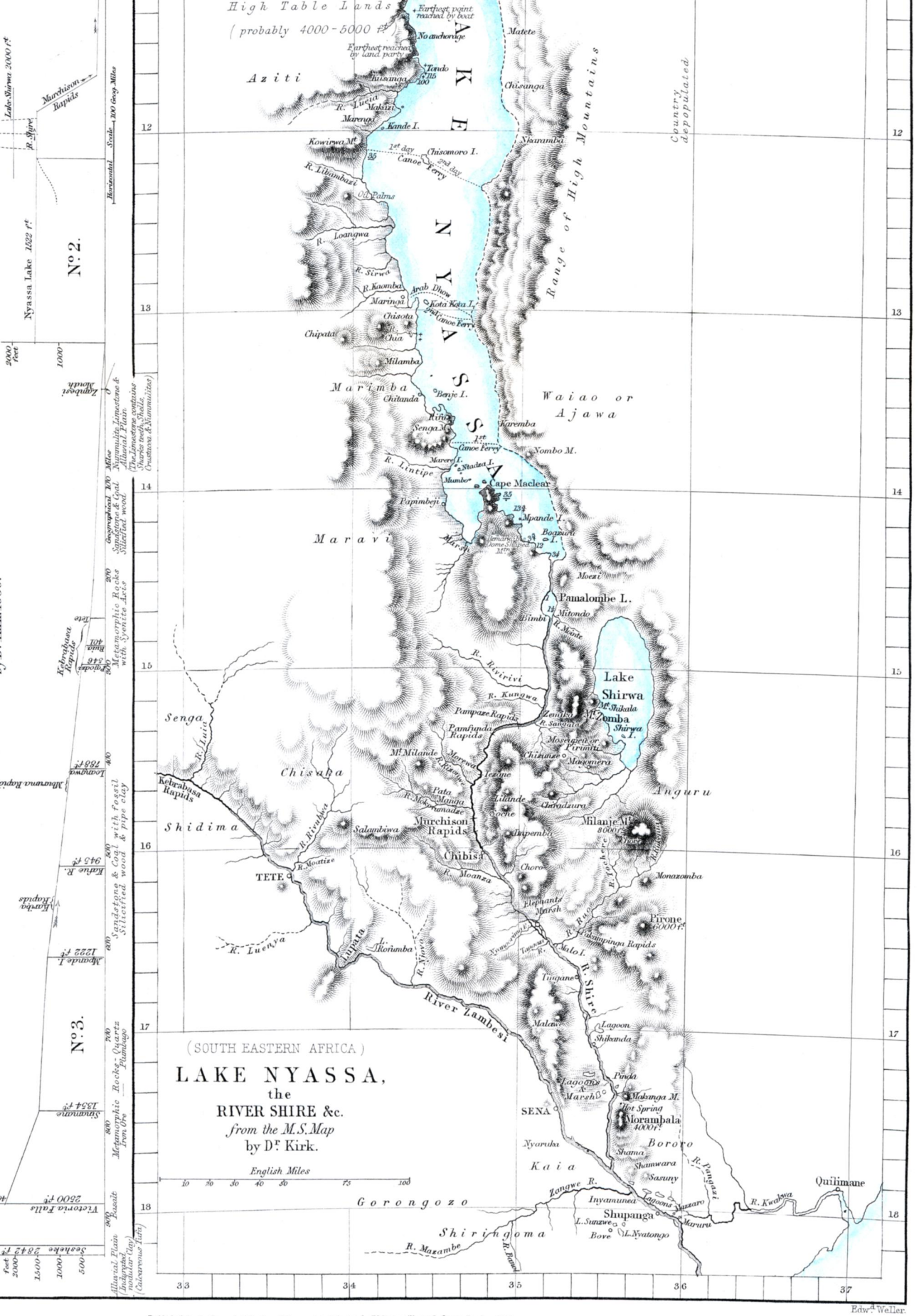
At low levels observations of the boiling-point of water proved of no use, but observations made with this instrument agreed very closely with the results of barometric heights at higher elevations: thus the results by both place the Victoria Falls at almost the same height above the sea, while the lower stations of Zumbo, &c., discord considerably. A similar observation has been made by Dr. Hooker in India.


Gradient on River Shire
from Barometric Observations
by Dr. Kirk. 1860.
No. 2.
Nyassa Lake 1522 ft.
Murchison Rapids
Lake Shirwa 2000 ft.
Chisanze Village 2800 ft.
Highlands 3000-4000 ft.
Zomba 7000 ft.
Morambala 4000 ft.
Horizontal Scale 100 Geog. Miles
Gradient on River Zambesi
from Barometric Observations
by Dr. Kirk. 1860.
No. 3.
Kebrabasa Rapids
Victoria Falls 2600 ft.
Metamorphic Rocks with Syenite Axis
Sandstone & Coal with fossil wood & pipe clay
Metamorphic Rocks - Quartz Iron Ore - Plumbago
Section in the line of the Murchison Rapids of the River Shire.
No. 1.
Batoka Plains 3500 to 4000 ft.
Sea Level

(SOUTH EASTERN AFRICA)
LAKE NYASSA,
the
RIVER SHIRE &c.
from the M.S. Map
by Dr. Kirk.
English Miles
LAKE NYASSA
High Table Lands (probably 4000-5000 ft.)
Range of High Mountains
Waiao or Ajawa
Maravi
Marimba
Aziti
Chisaka
Shidima
Senga
Lake Shirwa
Mt. Zomba
Murchison Rapids
Cape Maclear
Pamalombe I.
Chibisa
TETE
SENA
River Zambesi
R. Shire
Kebrabasa Rapids
Elephants Marsh
Gorongozo
Kaia


(SOUTH EASTERN AFRICA)
LAKE NYASSA,
the
RIVER SHIRE &c.
from the M.S. Map
by Dr. Kirk.
English Miles
0 10 20 30 40 50 75 100
LAKE NYASSA
High Table Lands
(probably 4000-5000 ft.)
Azaiti
Waiao or Ajawa
Maravi
Marimba
Senga
Chisaka
Shidima
Anguru
Bororo
Kaia
Gorongozo
Country depopulated.
Range of High Mountains
River said to enter here from a Marsh
Mt. Kumara
Sisia
Bandepe I.
Farthest point reached by boat
No anchorage
Matete
Farthest reached by land party
Tando
Risanga
Chisanga
R. Lucia
Makazi
Marenga
Kande I.
Kowirwa Mt.
1st day
Chisomoro I.
2nd day
Canoe Ferry
Nsaramba
R. Lilambazi
Old Palms
R. Loangwa
R. Sirwa
R. Kaombe
Arab Dhow
Kota Kota I.
2nd Canoe Ferry
Maringa
Chisota
R. Chia
Chipata
Milamba
Benje I.
Chitanda
Kirira
Senga Mt.
Karemba
1st Canoe Ferry
Yombo M.
Mavera I.
Nadzia I.
R. Lintipe
Mumbo
Cape Maclear
Papimbeja
Mpande I.
Boazuwi I.
Moezi
Pamalombe L.
Mitondo
Bimbi
R. Mande
R. Ririvi
Lake Shirwa
Mt. Shikala
Mt. Zomba
Shirwa I.
R. Kungwa
Pampaze Rapids
Zemba
R. Sanombe
Pamfunda Rapids
Maseneta or Pirimu
Mt. Milande
R. Morena
Chimanse
Maogmera
Kebrabasa Rapids
R. Mocanga
Pata
Manga
Tamadze
Tezime
Lulande
Chiradzura
Salambiwa
Murchison Rapids
Chibisa
Anjemba
Milanje Mt. 8000 ft.
R. Ruo
Monazomba
TETE
R. Moattize
Choroe
R. Moanza
Elephants Marsh
Pirone 6000 ft.
R. Luenya
Lupata
L. Konamba
R. Nyoro
Mpampinga Rapids
Mato I.
R. Shire
Inuganc
River Lambesi
Malewo
Lagoon Shikanda
Pinda
Lagoons & Marsh
Moksanga M.
Hot Spring
SENA
Morambala 4000 ft.
Nyaruba
Shama
Shamwara
Sasuny
R. Pangazi
Zanawe R.
Inyamunea
Lagoons
Nazaro
Quilimane
R. Kwakwa
Mt. Kumara 4000 ft.
Shinco
Nyassa Lake 1622 ft.
Marchison Rapids
R. Shire
Lake Shirwa 2000 ft.
Horizontal Scale 100 Geog. Miles
No. 2.
No. 3.
Zambesi Mouth
Alluvial Plain
Nummulite Limestone & Coal
(The Limestone contains Shells both, Shells, Crustacea & Nummulites)
Sandstone & Coal
Silicified wood.
Metamorphic Rocks with Syenite Axis
Sandstone & Coal with fossil wood & pipe clay
Metamorphic Rocks: Quartz Plumbago
Metamorphic Iron Ore
Basalt
Victoria Falls 2600 ft.
Shirwa 1854 ft.
Morambala 4000 ft.
Lake R. 945 ft.
Lumbo Rapids
Mpamba R. 1222 ft.
Mwanza Rapids 1788 ft.
Kebrabasa Rapids
Lupata Mouth
Zambesi Mouth

Published for the Journal of the Royal Geographical Society by J. Murray, Albemarle Street, London, 1865



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Edwd. Weller.

There is some difficulty in estimating the height of Tete (near the head of the lower navigable portion), distant 300 miles from the sea-coast. In this part the sea-air first comes over land and suffers changes which seem to cause a permanent depression of the barometric column, indicating a greater elevation above the sea-level than in fact exists.

With the windings of the river we may estimate the total length of this part as a little over 400 miles: in addition, the river is shallow and spread over flat sandbanks, causing a great amount of friction, so that, making all allowance for retardation, Tete cannot be over 400 feet, while the barometer would indicate 600.

As we pass further inland it is possible that an error from permanent depression of the mercury still increases; if so, the heights deduced will be too great, but against such a source of error there is no security even in countries further advanced than Africa. The elevation, however, as here given, will be found to be close approximations to the truth. Within the tropics the diurnal barometric wave follows the same course with unfailing regularity, unless during a storm, the difference of one day from another seldom exceeds one-tenth of an inch, and even these small changes are accompanied by a change in the quarter of the wind.

Where a series of observations have been made during the day at one station they have been reduced to the mean at the sea-level by applying a correction for the various hours, which in so steady a climate may with safety be done. This correction is founded on tables from observations in the centre of the continent and on the coast.

Level of Lake Nyassa.—In determining the level above the sea of the Nyassa Lake, we have first observations made on the 18th September, 1859, at the time when it was first reached by Europeans. The observations made then were:—

	Inches.
	28·38
	28·34
	28·36
Ind. error	0·04
	28·40 = 1575 feet.

Mean air temp. 70° above.
„ „ „ 80 below.

When we returned a second time to that lake under Dr. Livingstone, in August and September, 1860, the following observations were made:—

1st series, from 27th Aug. to 8th Sept., 1860. Inches.
Mean reading of 10 observations, corrected for Ind. error 28·42 } Air above 70°
2nd series, from 8th Sept. to 20th Oct., 1860.
„ 8 observations .. .. 28·54 } Air above 70°
Mean of simultaneous readings of standard bar, at foot of Murchison Rapids, corrected and reduced to 32° Fahr. Lat. 16° 2′ s. = 29·932. Air 63°.
1st series = 1543 feet.
2nd series = 1425 „

The 1st series taken on the second occasion I consider the best, and should therefore give it two values in taking the mean of the three sets, which will be 1522 ft.

Murchison Rapids.—A series of barometric observations taken during the journey up the Shire to gain the Nyassa, and again corrected on our return by the same route, with a few of the intermediate points checked by observations when first that country was entered by Dr. Livingstone and myself, furnish the accompanying section in which are indicated the chief rapids through which the water of Nyassa descends from its own level, 1522 feet, to nearly that of the ocean.

The rapids have been named after the distinguished President of the Royal Geographical Society, to whose patronage African geography is so deeply indebted.

The levels of the respective rapids are calculated to corresponding observations made on board the *Pioneer*, at anchor in the Shire at their foot, to which 100 feet has been added as the probable difference between that station and the sea-coast.

Lake Shirwa.—The water-level of Lake Shirwa, in lat. s. 15° 23′, was ascertained by observation of aneroid barometer when that lake was discovered—the only time when scientific instruments have been taken to its edge.

The barometer, corrected for index errors, showed 27·86 at noon of 18th April, 1859, =2000 feet above sea-level.

XV.—*A Visit to the Wahabee Capital, Central Arabia.* By Lieut.-Colonel Lewis Pelly, H.M. Political Resident, Persian Gulf.

Read, June 12, 1865.

About a year ago, Mr. Frere, the President of the Geographical Society of Bombay, attracted my attention to the Proceedings issued by the Royal Geographical Society on the 28th of April, 1864, showing that certain questions had been mooted in London relative to the geography of the interior of Arabia, and that it was still a desideratum to determine with scientific accuracy